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Certificate
PATENT OFFICE
REPUBLIEK VAN SUID-AFRIKA

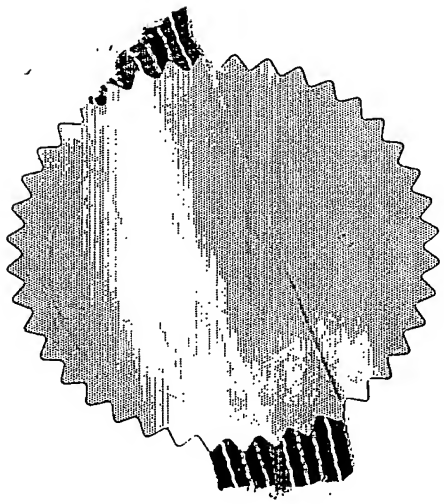
DEPARTMENT OF TRADE
AND INDUSTRY

Hiermee word gesertifiseer dat
This is to certify that

the documents annexed hereto are true copies of:

Application forms P. 1 and P.3, provisional specification and drawings of South African Patent Application No. 2003/0684 as originally filed in the Republic of South Africa on 24 January 2003 in the name of CSIR for an invention entitled: " PROTECTIVE FOOTWEAR ".

Geteken te PRETORIA in die Republiek van Suid-Afrika, hierdie 4th dag van June 2003
Signed at PRETORIA in the Republic of South Africa, this 4th day of June 2003



Registrateur van Patente
Registrar of Patents

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978
APPLICATION FOR A PATENT AND
ACKNOWLEDGEMENT OF RECEIPT
(Section 30(1) Regulation 22)

REPUBLIC OF SOUTH AFRICA
FORM P.1 REVENUE
(to be lodged in duplicate)
24 1.03 R 266,00
INKOMSTE
REPUBLIEK VAN SUID AFRIKA
A&A REF NASR15571 SGE/cvo

THE GRANT OF A PATENT IS HEREBY REQUESTED BY THE UNDERMENTIONED APPLICANT ON THE BASIS OF THE PRESENT APPLICATION FILED IN DUPLICATE

21	01	PATENT APPLICATION 2003/0684

71	FULL NAME(S) OF APPLICANT(S)

CSIR

ADDRESS(ES) OF APPLICANT(S)

Scientia
Pretoria
Gauteng
Republic of South Africa

54	TITLE OF INVENTION

PROTECTIVE FOOTWEAR

Only the items marked with an "X" in the blocks below are applicable.

[ ] THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. The earliest priority claimed is
Country: No: Date:

[ ] THE APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO 21 01

[ ] THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND BASED ON APPLICATION NO 21 01

THIS APPLICATION IS ACCOMPANIED BY:

X	A single copy of a provisional specification of 14 pages
X	Drawings of 2 sheets
	Publication particulars and abstract (Form P.8 in duplicate) (for complete only)
	A copy of Figure of the drawings (if any) for the abstract (for complete only)
X	An assignment of invention
	Certified priority document(s). (State quantity)
	Translation of the priority document(s)
	An assignment of priority rights
	A copy of Form P.2 and the specification of RSA Patent Application No 21 01
X	Form P.2 in duplicate
X	A declaration and power of attorney on Form P.3
	Request for ante-dating on Form P.4
	Request for classification on Form P.9
	Request for delay of acceptance on Form P.4
	Extra copy of informal drawings (for complete only)

74	ADDRESS FOR SERVICE: Adams & Adams, Pretoria

Dated this 24 day of **January 2003**

ADAMS & ADAMS
APPLICANTS PATENT ATTORNEYS

The duplicate will be returned to the applicant's address for service as proof of lodging but is not valid unless endorsed with official stamp

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2003 -01- 24
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PRETORIA

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978
DECLARATION AND POWER OF ATTORNEY
(Section 30 - Regulation 8, 22(1)(c) and 33)

FORM P.3

PATENT APPLICATION NO		A&A Ref:	V15571 SCF/cve	LODGING DATE	
21	01 2003/0684			22	24 January 2003

FULL NAME(S) OF APPLICANT(S)	
71	CSIR

FULL NAME(S) OF INVENTOR(S)	
72	JOYNT, Vernon Peregrin VAN DYK, Jacobus Theodorus

EARLIEST PRIORITY CLAIMED	COUNTRY		NUMBER		DATE	
	33		31		32	

NOTE: The country must be indicated by its International Abbreviation - see schedule 4 of the Regulations

TITLE OF INVENTION	
54	PROTECTIVE FOOTWEAR

* I/We STRYDOM, Johan

hereby declare that :-

~~1. I/we am/are the applicant(s) mentioned above;~~

** 2. I/we have been authorized by the applicant(s) to make this declaration and have knowledge of the facts herein stated in the capacity of Technology Manager of the applicant(s);

*** 3. the inventor(s) of the abovementioned invention is/are the person(s) named above and the applicant(s) has/have acquired the right to apply by virtue of an assignment from inventor JOYNT, VERNON PEREGRIN, and by virtue of the provisions of Section 13 of Act 46 of 1988 in respect of inventor VAN DYK, JACOBUS THEODORUS;

4. to the best of my/our knowledge and belief, if a patent is granted on the application, there will be no lawful ground for the revocation of the patent;

**** ~~5. this is a convention application and the earliest application from which priority is claimed as set out above is the first application in a convention country in respect of the invention claimed in any of the claims; and~~

6. the partners and qualified staff of the firm of **ADAMS & ADAMS**, patent attorneys, are authorised, jointly and severally, with powers of substitution and revocation, to represent the applicant(s) in this application and to be the address for service of the applicant(s) while the application is pending and after a patent has been granted on the application.

SIGNED THIS 17 DAY OF January 2003

J Strydom

Company Name: CSIR
Full Names: Johan Strydom
Capacity: Technology Manager

(no legalization necessary)

* In the case of application in the name of a company, partnership or firm, give full names of signatory/signatories, delete paragraph 1, and enter capacity of each signatory in paragraph 2.
** If the applicant is a natural person, delete paragraph 2.
*** If the right to apply is not by virtue of an assignment from the inventor(s), delete "an assignment from the inventor(s)" and give details of acquisition of right.
**** For non-convention applications, delete paragraph 5.

A&A P203

& A Ref No: V15571 SCF/cve

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FORM P6

REPUBLIC OF SOUTH AFRICA
Patents Act, 1978

PROVISIONAL SPECIFICATION

(Section 30 (1) - Regulation 27)

21	01	OFFICIAL APPLICATION NO

2003/0684

22	LODGING DATE

24 January 2003

71	FULL NAME(S) OF APPLICANT(S)

CSIR

72	FULL NAME(S) OF INVENTOR(S)

JOYNT, Vernon Peregrin
VAN DYK, Jacobus Theodorus

54	TITLE OF INVENTION

PROTECTIVE FOOTWEAR

This invention relates to protective footwear. It relates more specifically to protective footwear for protecting a wearer against the effects of a landmine explosion, especially an anti-personnel landmine explosion.

Although the Applicant does not wish to be bound by theory, it is nevertheless believed that a theoretical explanation of some concepts relating to the effects of a landmine explosion will assist the reader in appreciating the inventive contribution which the inventors have made and the principles underlining this invention. Thus, some concepts of relevance are briefly explained.

The Applicant has appreciated that shockwaves play an important role in the field of the invention and, in contra distinction to other inventors in the field, has focused efforts in understanding and dealing with the shock wave effect of a landmine explosion.

Shock waves are in certain respect equivalent to acoustic waves, for example, progression of a shock wave through a material is not associated with transfer of mass or particles, it progresses as a wave. Furthermore, the speed of progression through a material is dependent on physical properties of the material, i.e. in the case of solid material, is proportional to the density and inversely proportional to the Young's modulus of the material. Yet further, the Applicant has appreciated the significance that speed of progression through liquids differ, and is generally lower than that through "rigid" solids such as ceramics, metals, and the like, but generally higher than through gasses such as

air. Yet further, the role that temperature of a gas plays in respect of acoustic speed is significant – e.g. the acoustic speed through air at 1000°C is more than twice the acoustic speed through air at normal ambient temperature. Still further, the acoustic speed is surprisingly low through "elastic" materials such as rubber, some synthetic polymeric materials, and the like. Although this kind of information is know, the significance in the field of the invention has not thus far been appreciated or has not been appreciated fully by other experts in the field of the invention.

A further aspect appreciated by the Applicant is that, although only about 40% of energy associated with a landmine explosion is present as shock wave energy, dealing with the shock wave energy, surprisingly, has an important influence or effect on the major portion (about 60%) of energy associated with blast effect created by a landmine explosion. This phenomenon is explained below.

In accordance with a first aspect of the invention, in ameliorating the effect of a landmine explosion on a human, there is provided a method of guiding shock waves obliquely away from a foot of the human by means of correspondingly obliquely arranged shock wave guide members embedded in a sole volume of a protective boot or shoe worn by the human.

The shock waves may be guided obliquely laterally outwardly.

The shock wave guide members may be selected to have a high acoustic speed.

In this regard, it is to be appreciated that, for purposes of this invention, direction, orientation, and the like must be interpreted in relation to a boot in its normal orientation i.e. the toe end of the boot will be regarded as a "fore-end" or "front end"; the heel end will correspondingly be regarded as the

"rear end"; the sole of the boot will be at the under side or bottom of the boot; a side of the boot corresponding to a big toe of the wearer will be regarded as the "inside" and correspondingly the side of the boot associated with the small toe of the wearer will be regarded as the "outside" or "outer side".

The method may include absorbing heat energy by evaporating liquid contained in the sole volume, conveniently liquid surrounding the guide members. The liquid, ideally, will have a high latent heat value and a low boiling point. Water, a mixture containing water, and the like are regarded as suitable.

By way of development, the method may include covering the guide members from above by means of a solid shield arranged in the sole volume above the guide members. The shield may be oriented obliquely in correspondence with orientation of the guide members. The shield may be anchored by means of an integral decumbent flange toward a top of the sole volume. When oriented obliquely, the shield will act as a deflector of shock waves.

Further in accordance with the first aspect, there is provided an article of protective footwear for a human in the form of a boot or shoe having a composite sole including an outer sole at a bottom, a spaced inner sole below a foot cavity, and a sole volume intermediate the outer and the inner soles, the composite sole including shock wave guide members oriented obliquely.

The shock wave guide members may be arranged to extend from about the outer sole obliquely upwardly to a laterally outward extremity of the composite sole. The shock wave guide members may be curved from a generally steeply sloped orientation at their upstream ends proximate the outer sole to a relatively shallow sloped orientation at their downstream ends proximate the laterally outer extremity.

The shock wave guide members may be of solid material having a relatively high acoustic speed, e.g. ceramic, glass, metal, or the like. The shock wave guide members may advantageously and conveniently be in the form of glass fibres.

The composite sole volume may contain a liquid among the shock wave guide members. The liquid may be in the form of a gel, viscous fluid, or the like. The liquid may be or may contain a mixture of water and alcohol, e.g. between about 50% and about 90% water, preferably about 70% water.

Correspondingly, by way of development the composite sole may incorporate a shield covering the shock wave guide members when it will act also as a deflector deflecting shock waves generally laterally outwardly. The shield may be oriented obliquely in correspondence with the shock wave guide members. The shield may be of a robust sheet material, e.g. a synthetic material such as Kevlar, a metal such as a light metal alloy, e.g. titanium, aluminum or magnesium alloy, or the like.

The shield may be integral with an anchor formation for anchoring it in the sole volume. The anchor formation may be generally decumbent below the inner sole.

The Applicant has observed, surprisingly, that the blast effect of a landmine explosion tends to follow the direction of the leader wave which is a shock wave. The Applicant has appreciated the significance that the shock wave leads the blast effect because of the generally higher progression rate of the shock wave than the progression rate of the blast. Again, without wishing to be bound by theory, the Applicant believes that progression of a shock wave, especially through a material having relatively high acoustic resistance, in other words through a material having a relatively low acoustic speed, causes the material to be heated by loss of energy of the shock wave as it progresses

through the material. In the case of a material of low acoustic speed, the residence time is longer, the "resistance" is higher, and the energy loss is higher thus enhancing the temperature rise. Heating of the air ahead is enhanced by radiation which happens at the speed of light, preheating that air ahead of the acoustic wave. The region of high temperature in air, where this phenomenon can most easily be observed, increases the acoustic speed. As mentioned at the outset of this specification, the acoustic speed of air at 1000°C is more than twice the acoustic speed of air at normal ambient temperature. Thus, such temperature rise enhances progression of shock waves through that region and concentrates shock waves in that region i.e. it "deprives" relatively lower temperature regions of the presence of shock waves. All of this has the very interesting and, in accordance with this invention useful, effect of causing the blast effect to follow the leader shock wave. Thus, if the shock wave is guided obliquely laterally away from the body of the victim, not only does the victim have the advantage of encountering a lesser amount of shock waves, or of encountering the shock waves to a lesser extent, it also has the advantage of encountering a lesser amount of the following blast. Thus, guiding the shock wave away from the body has the expected primary advantage, but it leads also to the above, surprising, secondary advantage in respect of the following blast.

The Applicant believes that this invention provides, in the first instance, for guiding of the shock waves laterally obliquely away from the body, but also provides for deflecting of the remaining shock waves laterally obliquely away from the body.

In accordance with a second aspect of the invention, in ameliorating the effect of a landmine explosion on a human, there is provided a method of checking progression of a shock wave through a sole volume of an article of protective footwear by means of a layer of material having a low acoustic speed arranged underneath an inner sole.

The acoustic speed may be lower than about 100 m/s. It may be in the form of vermiculite, or a composite material containing vermiculite. The Applicant has, surprisingly, realized that vermiculite which has an acoustic speed approaching zero, and that it will be particularly effective in checking progression of a shock wave.

Accordingly, the second aspect of the invention extends to an article of protective footwear such as a boot or shoe having a composite sole including an outer sole, a spaced inner sole and a sole volume intermediate the outer and inner soles, the composite sole volume containing a layer of material having an acoustic speed lower than about 100 m/s.

The material may be vermiculite, or a composite material containing vermiculite.

When the shoe or boot is in accordance with the first aspect having the shield and the anchor member, the layer of material of low acoustic speed may be contained intermediate the shield and the anchor member.

In accordance with a third aspect of this invention, in ameliorating the effect of a landmine explosion on a human, there is provided a method of enhancing shock wave progression through a foot of a human downstream of the foot by means of a layer of material in close contact with skin along an upper foot surface, the layer of material having an acoustic speed equal to or higher than acoustic speed of flesh.

The acoustic speed of the layer of material may be larger than the acoustic speed of water. The material may be, or may include, glycerin.

The method may include containing the layer of material in association with a sock worn by the human.

Further in accordance with the third aspect, there is provided an article of footwear for a human including a layer of material having an acoustic speed equal to or larger than the acoustic speed of flesh and arranged to be in close contact with skin at a top, sides and back of a foot of a human.

The material may be, or may include, glycerin. It may be contained in a pad, sachet or the like. It may be located on or in a sock. The sock may be of thin polyurethane material. The sock and the pad, sachet or the like, may be arranged to extend also along a leg of a user, say from an ankle of a user upwardly, advantageously to a level higher than an upper extremity of the boot.

By way of development, the material may be provided in amongst granular or, preferably, filamentary material having high acoustic speed, e.g. a roving of glass fibers. Thus, the sachet or pad may be filled or stuffed with glass fibre roving, and glycerin may displace all air or other gas fully to fill the sachet or pad.

The third aspect extends yet further to a protective footwear system comprising a protective boot and such a sock.

The third aspect of this invention focuses on a phenomenon which has not yet received any attention from inventors. To the best of the Applicant's knowledge, without exception, all attention thus far was directed at ameliorating the effects of a landmine explosion upstream of the body (foot) of the human to be protected, and no attention whatsoever has been paid to an area downstream of a foot of a human. The Applicant has, surprisingly, noticed in boots worn by landmine explosion victims that, in many instances, a respective boot was virtually unharmed in the sole area, whereas the upper was shattered. The Applicant has concluded that shock waves act in a manner similar to light waves when it reaches an interface between materials of different optical / acoustic

density. Contrary to instinct, the Applicant believes that a sound wave moving through a relatively dense material and reaching an interface with a material of relatively low density reflects or deflects from the interface back into the higher density material, at least partially. Without wishing to be bound by theory, the Applicant believes that the reason for this is that the acoustic speed through the relatively dense material is generally higher than the acoustic speed through the material of relatively low density, and thus, for an acoustic wave, the material of lesser density is actually also a material of higher resistance, thus the tendency to reflect or deflect. Such reflection or deflection causes interference between approaching sound waves and deflected or reflected sound waves which can give rise to resonance and other effects causing a concentration of energy and resultant spalling of the higher density material proximate the interface.

Thus, the Applicant has concluded that, in the foot of a landmine explosion victim, it is generally impossible to shield the foot entirely from shock waves. Thus, shock waves progressing through the foot of the victim, at the upper surface of the foot, encounters a material of lesser density, namely air, causing the shock waves to reflect or deflect, thus causing spalling in the foot and also in the upper of the boot. The Applicant believes that this is a possible explanation for the surprisingly large structural damage of the foot and downstream of the foot of a landmine explosion victim.

Thus, in accordance with the third aspect, the Applicant proposes providing a medium or material of <u>higher</u> acoustic speed than the acoustic speed through the foot of the victim to <u>promote</u> transfer of or progression of shock waves through the interface into the downstream medium. The Applicant expects that this will greatly ameliorate the destructive effect of shock waves which do find their way into the body (foot) of the victim. The Applicant believes that spalling would take place, but downstream of the material of higher acoustic speed at that material's interface with ambient air and that the resultant spalling would not have an undue effect on the foot of the victim.

The Applicant also realizes that human bone has a higher acoustic speed than human flesh and that sound waves penetrating the victim's foot will have a tendency to progress along the bones of the victim in preference to flesh of the victim. This may result in the shock waves having a tendency to progress upwardly along the bones in the lower leg of the victim. Thus, the Applicant proposes extending the material of relatively high acoustic speed around the lower leg up to a relatively high level, preferably at least somewhat higher than the upper extremity of the boot.

The invention is now described by way of example with reference to the accompanying diagrammatic drawings. In the drawings

Figure 1 shows, in sectional front view, a foot of a human within a protective boot in accordance with the invention; and

Figure 2 shows the arrangement of Figure 1 in sectional side view.

With reference to the drawings, a protective boot in accordance with the invention is generally indicated by reference numeral 10. The boot 10 is used by a human represented in the drawings by his foot 12.

The protective boot 10 has an upper 14 above a composite, thick sole generally indicated by reference numeral 16 and comprising an outer sole 18 at a bottom thereof, an inner sole 20 at the top of the composite sole 16 immediately underneath a foot volume 38 defined by the upper 14. The boot 10 further comprises an inner side 22 associated with a big toe of the user, and an opposed outer side 24. A sole volume 26 is defined between the inner and outer soles and between the inner and outer sides. As mentioned above, the thickness or height of the sole volume 26 is substantial. Furthermore, the composite sole 16 is of generally bell shape tapering from the outer sole toward the inner sole.

In accordance with the first aspect of the invention, a plurality of shock wave guide members 28 is provided in a particular position and a particular orientation within the sole volume 26. The shock wave guide members 28 are of elongate shape, advantageously in the form of bundles of glass fibre. The shock wave guide members 28 extend respectively from just above the outer sole 18 obliquely upwardly and laterally outwardly toward the outer side 24. The shock wave guide members 28 are of a material having a high acoustic speed to promote progression of shock waves along the guide members as opposed to transversely across the guide members.

The shock wave guide members, advantageously in the form of woven fibre-glass cloth tubes that have been filled with bundles of straight fibre-glass fibers running the length of the cloth tubes are thus surrounded by the liquid such that gas, e.g. air is displaced and is not present within that portion of the sole volume.

By way of development, advantageously, the portion of the sole volume 26 occupied by the shock wave guide members 28 also contains a liquid, gel, viscous liquid, or the like having high latent heat of evaporation and a low boiling point. In this instance, the liquid is a mixture of water and alcohol (methanol) in a 70-30 mass proportion.

Further in accordance with the first aspect, the portion of the sole volume containing the shock wave guide members 28 and liquid 30 is covered by an oblique shield or deflector 32 extending generally from an inner lower extremity of the composite sole 16 toward an upper outer corner of the composite sole 16. Preferably, the shield 32 is extended in integral manner into an anchor member 34 extending generally decumbently immediately underneath the inner sole 20. The shield 32 and anchor member 34 are conveniently in the form of bent plate material such as titanium, aluminum, aluminum alloy, or the like.

The shield 32 may, however, preferably, be in the form of carbon fibre or Kevlar fibre embedded in epoxy resin defining the shape of the shield. The V-shaped spacing between the shield and the anchor member is advantageously webbed at intervals to enhance mechanical strength and rigidity.

In accordance with a second aspect of the invention, in a region of the sole volume 26 above the shield 32, and thus below the inner sole 20, there is provided a material having very low acoustic speed to provide a shock wave barrier. The Applicant has, surprisingly, found that the acoustic speed of vermiculite is or approaches zero and the use of vermiculite is, for this reason, favored. This material is indicated in the drawings by reference numeral 36 and is, preferably, in the form of coarse vermiculite chunks compressed and bonded together with a polyurethane bonding elastomer. The preformed compressed pieces are strengthened with internal binding material to give the shock wave barrier maximum physical strength without nullifying the very low shock wave transmission properties of the vermiculite. The binding material may be Kevlar cloth impregnated with an elastomer bonding material like isoprene.

If, instead, the shield and anchor plate are of metal, titanium would be a preferred metal.

It is important that the shield and anchor plate should remain intact and should not be fragmented or broken up by the blast.

In accordance with the third aspect of the invention, there is provided a space between upper and side surfaces of the foot 12 and the upper 14, which volume is filled by means of a liquid, or semi-liquid able to take up the shape of the foot 12 such that it can be brought into close contact with the skin and having a high acoustic speed, i.e. higher than the acoustic speed of flesh, e.g. glycerin or glycerin based mixtures. The liquid, e.g. glycerin, is contained in

pads or sachets 40. The pads 40 may have outer skins of very thin and strong polyurethane. By way of development, the pads 40 may be filled with maximum amounts of fibre-glass roving, the glycerin then surrounding the fibre-glass roving and ensuring that all air is displaced.

Advantageously, the pads 40 are mounted on, or secured on a thin polyurethane sock donned by the wearer in the usual fashion.

It is important to appreciate that, although the area underneath the sole of the foot 12 is devoid of such pads, the pads surround the sides and top and also the back of the foot 12 and extends, surrounding the leg 13, to an elevation at least somewhat higher than the top of the boot.

It is of extreme importance that close contact be established between the skin of the foot and the inner surface of the pads. It is thus proposed that the pads have excess volume, and that the boot is tied relatively tightly around the foot and leg to compress the pads onto the surface of the foot and leg, the excess volume being displaced to above the upper extremity of the boot.

To sum up, the Applicant believes that a foot system comprising the protective boot 10 and the sock incorporating the pads 40 would function generally as follows:

Initial forced shock waves developed or generated by explosion or detonation of the mine are diverted or guided away by the shock wave guide members and are further attenuated by the liquid surrounding the shock wave guide members acting as heat absorption medium. The change of direction of the leader shock wave then establishes a route into and in the air for the blast products following. The direction is chosen to be away from vulnerable parts of the victim's body. The force of the blast wave and its products then follow the

established direction while the shield protects the foot from over-pressure and hard products. Any remaining or errant shock waves that may find their way past the shield are checked or severely attenuated by means of the vermiculite barrier. Any remaining shock waves penetrating the victim's foot and ankle are promoted to progress through the foot and into the pads of glycerin without losing undue amounts of energy while progressing through the foot and without spalling in the foot. The wide bottom of the boot distributes the energy absorption layers over the ground contact parts of the sole to prevent blow-past effects when a landmine explodes or detonates while not properly under the sole of the boot.

The Applicant believes that this invention incorporates a number of new, inventive and very effective ways of ameliorating the effects of a landmine explosion on the body of a human in an elegant and practical embodiment.

DATED THE 24th DAY OF JANUARY 2003

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APPLICANT'S PATENT ATTORNEYS

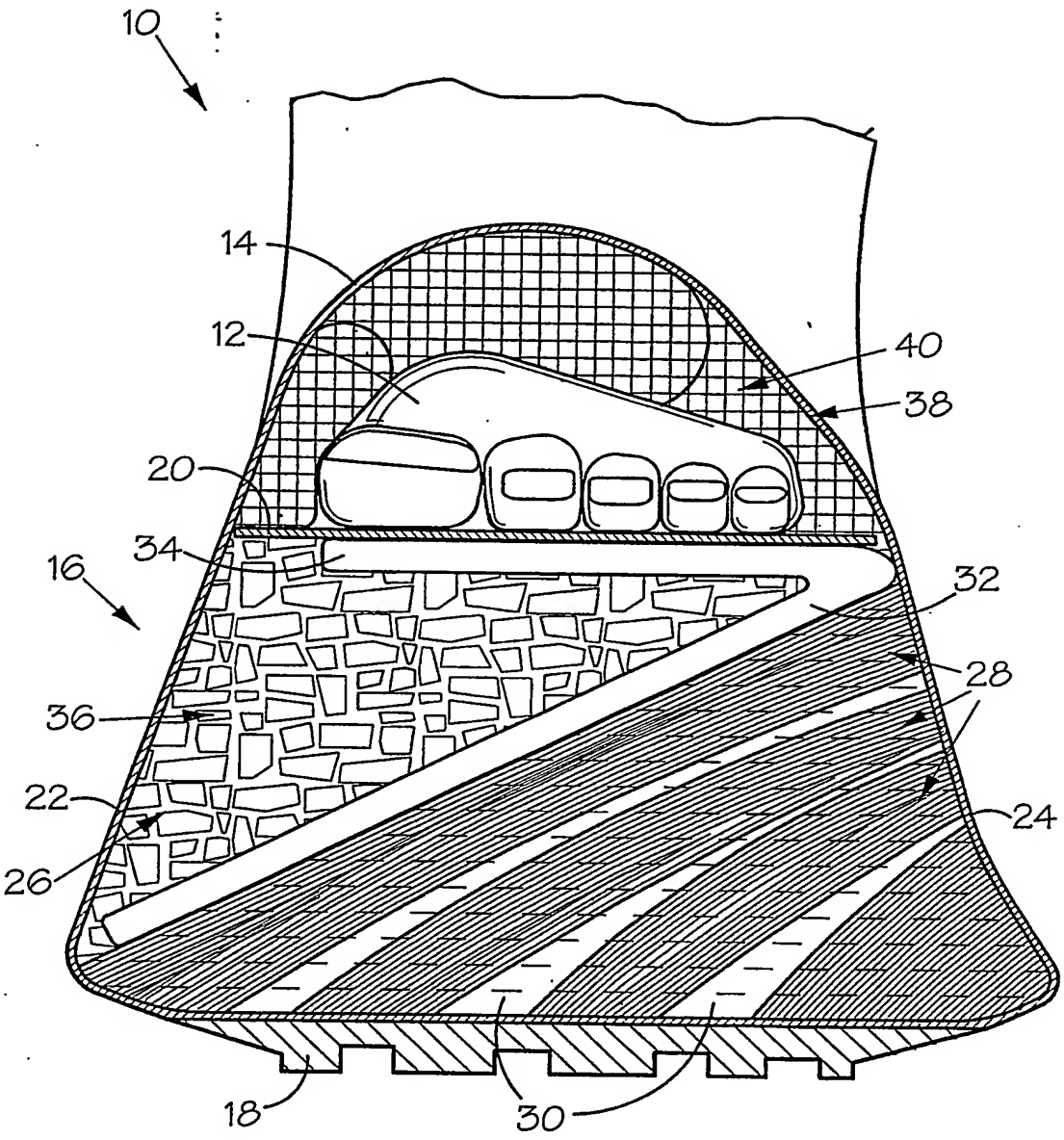

FIG 1

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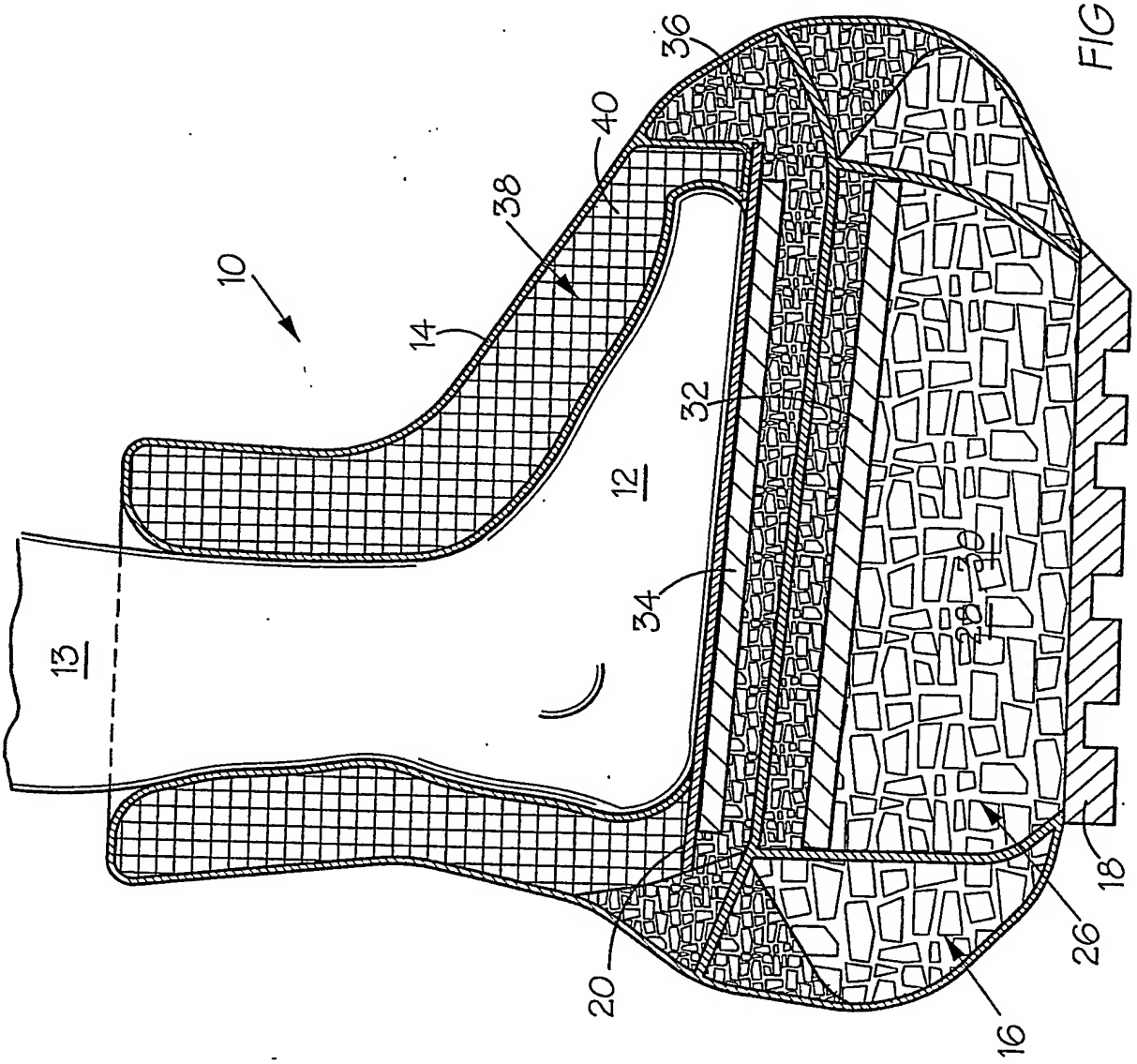

FIG 2

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